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(54) Data-loss prevention

(57) This invention provides: a data-loss prevention software product; methods of preventing data loss; and personal computer systems and networks using said data-loss prevention product. Preferred embodiments provide DOS computer systems, especially networked, with continuous, on-line, real-time back-up by way of replication of all drive read/write activity to a primary and one or more secondary logical drives. Users are alerted to drive failure and user-confirmed automatic continuation of processing or non-stop processing, on a secondary drive is also provided.

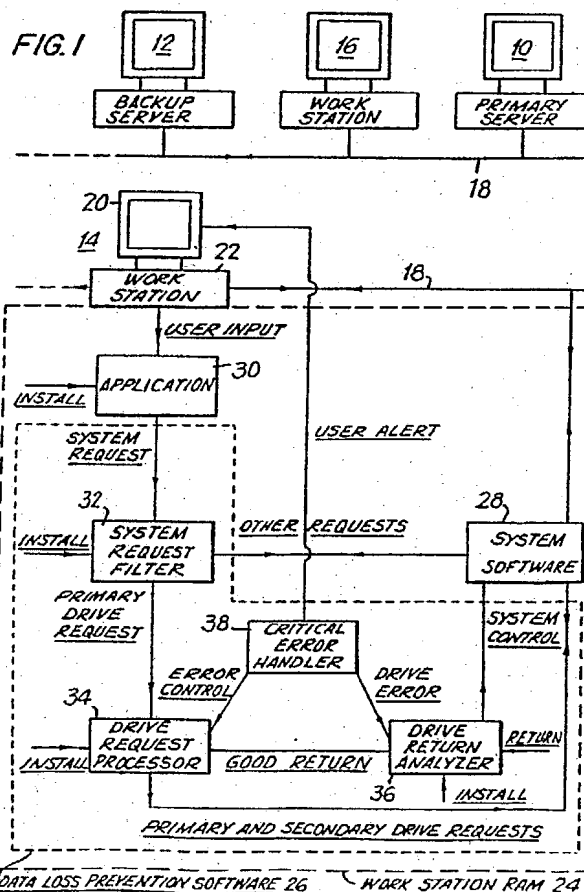
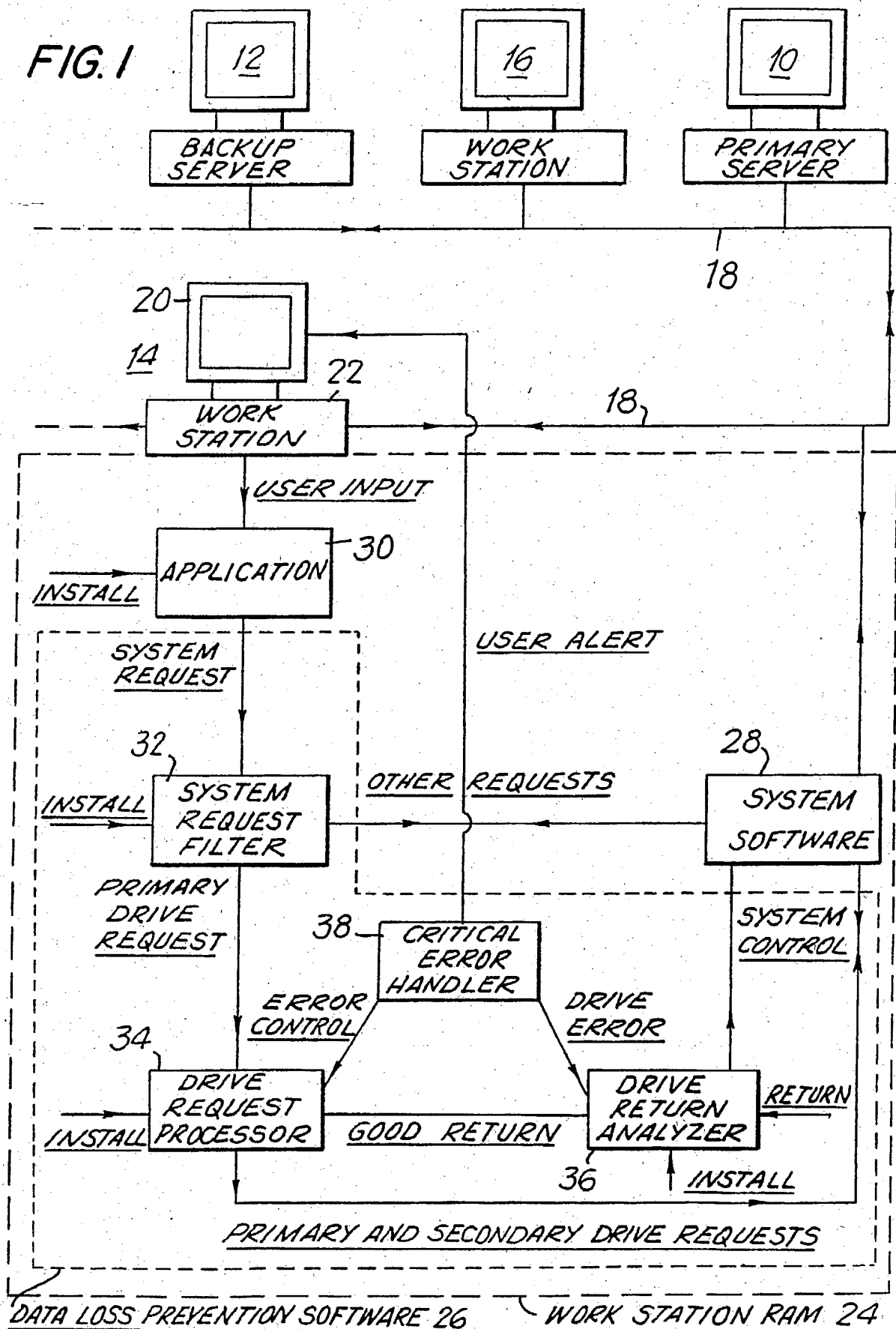


FIG. 1



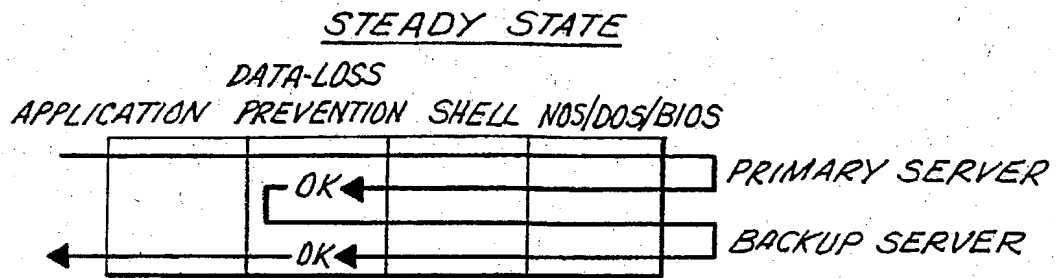


FIG. 2

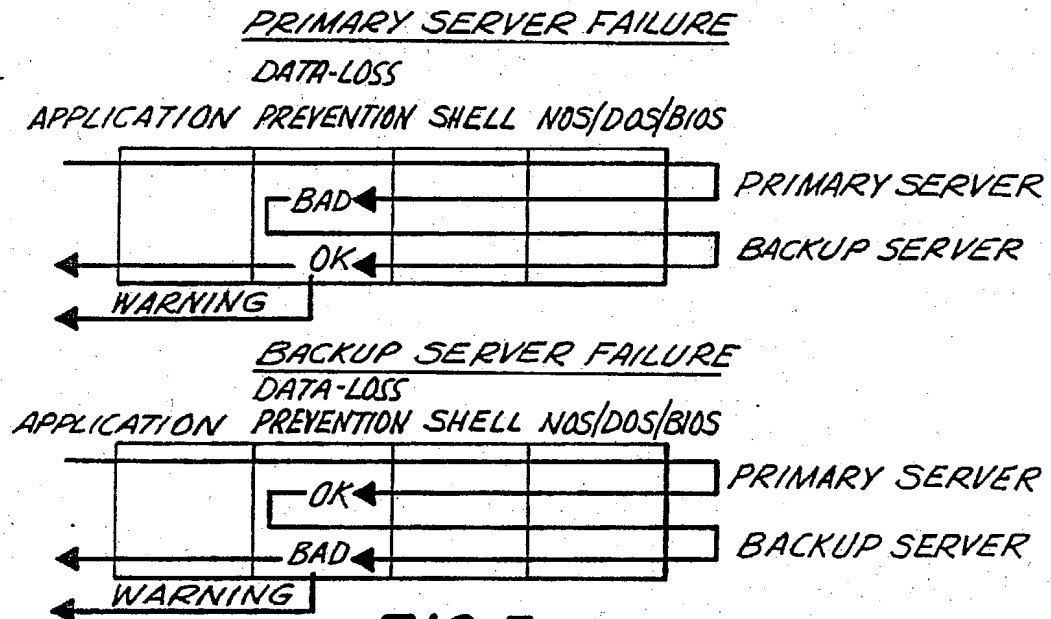


FIG. 3

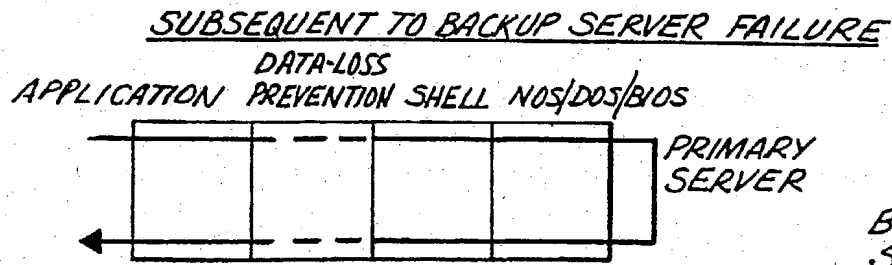
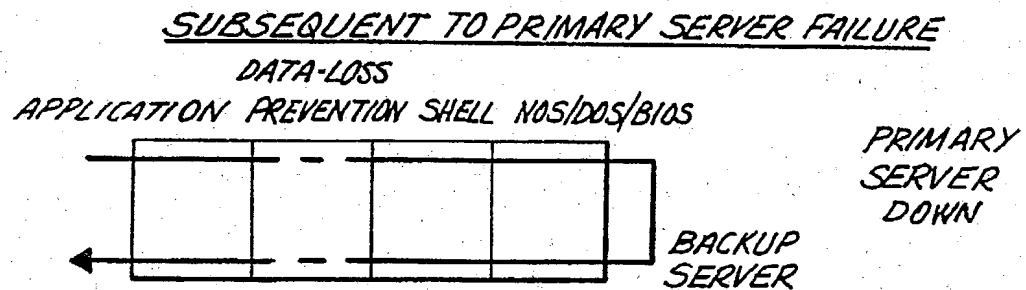


FIG. 4

DATA-LOSS PREVENTION PRODUCTS

This invention relates to improvements in personal computer systems and software therefor. More particularly, it relates to a software product for preventing data loss, especially in DOS computer systems, to a computer system which includes such a software product, and to a method of preventing such data loss.

Preferred embodiments of the invention relate to intelligent personal computer workstations networked to a file server running under a network operating system such as Netware (Novell Inc.) or 3+Share, (3COM Corp). Unless defined otherwise, implicitly or explicitly, the terminology used herein should be construed to be consistent with the usage of Microsoft Corporation in "Microsoft MS-DOS User's Guide Version 3.3" 1987.

The field of DOS computers to which this invention is applicable, in preferred embodiments, comprises personal computers capable of loading and running version 3.1 or higher of Microsoft Corporation's MS-DOS operating system or IBM Corporation's version thereof which is itself known as "PC-DOS". An example is an IBM PS/2 computer equipped with an Intel 80286 or 80386 processor (Intel Corporation).

More specifically, the intelligent personal computer workstations referred to herein are personal computers or microcomputers to be distinguished from mini- or main-frame computers, with which this invention is not concerned except inasmuch as they might connect with or communicate with a computer being an embodiment of the present invention or simulate such a computer.

Three levels of fault tolerance are recognized in the data processing arts for "hot backup" systems that provide continual on-line automated data duplication at a computer workstation.

Level 1 fault tolerance protects a primary drive on the computer station against disk medium failures (e.g., bad spots) by mirroring file accesses, maintaining a duplicate copy of each file on the same physical volume. It does not protect against disk subsystem failures, system failures or, on a computer network, against file server failures or cabling failures.

Level 2 fault tolerance protects against disk medium failures, disk subsystem failures and file server-to-disk subsystem cabling failures. This is accomplished by duplexing file accesses on a backup disk subsystem of the computer station. It does not protect against file server failures or workstation-to-file server cabling failures.

The objective of level 3 fault tolerance is to protect against disk medium failures, disk subsystem failures, file server failures, file server-to-disk subsystem cabling failures and file server-to-network workstation-to-file server cabling failures (assuming a good connection still exists between the workstation and the remaining server). This is only achievable by duplicating primary disk activity at a second computer station.

DOS is a unique but somewhat limited operating system. It is economical and widespread with millions of copies in use on millions of computers. A well-known limitation of DOS is its inability to address random access memory (RAM) in excess of 640KB. Further limitations relate to backups. Specifically, DOS provides only for batch-process back-ups that proceed incrementally, blocks of data being sequentially read from a primary drive then written to a secondary drive. Exclusive use of the file is required and its data cannot be read or changed during the backup procedure.

Software-based backup utilities such as Fastback Plus from Fifth Generation Systems and Backit from Gazelle Systems are commonplace and suffer similar limitations: they are incremental and require exclusivity.

Hardware means for "disk-mirroring" are known, e.g. DPT Smart Cache mirroring, but hardware can fail, decreasing the mean

time between failures overall. Further, such hardware systems are incapable of meeting the objects of the present invention.

Novell Inc., currently the premier supplier of network operating systems, provides in System Fault Tolerant Netware version 2.15 and Netware 386, for disk mirroring or duplexing on a file server offering Level 2 fault tolerance protection against failures of the disk medium, disk sub-system or server-to-disk cabling. The software is expensive (currently listing at \$4,995.00 and up, Harvard Data Systems, Norfolk, MA.) and limited: it is not a DOS system and is not flexible, although it is designed to run on a range of DOS computers. Furthermore, the software requires a hardware kit to achieve drive duplexing, and the Novell products are therefore incapable of meeting the objectives of the present invention.

LanServices Inc. LANShadow provides for backup to a second server on a network by means of copy passes at user-specified intervals. This is incremental backup. In the event of catastrophe, data must be re-keyed to open files. Presumably, all data changes since the last copy pass, whenever that was, must be re-keyed. Since the precise extent to which the backup lags live transaction activity is unknown, the immediate transaction history must be re-constructed manually and compared with the backup data: a difficult, time-consuming, and error-prone process on a network with many users. During this

time, data integrity requirements dictate close-down of the network. This drawback is exacerbated with a large active database of tens or hundreds of megabytes or more because each change to a single record may have to be backed up by copying the whole file, a process which can take several minutes, implying the backup must be substantially out of date. Further, LANShadow is not a DOS utility: it is designed to run under Novell.

Also known are software utilities that compile a transaction log of all changes to a database. To achieve this, the user's command lines are stored to a file which can be used to reconstruct a current version of a database from a backup version. This is a slow process, especially with many operators using the data file, since every command line has to be executed sequentially on the backup version.

It is an object of the present invention to provide an improved data-loss prevention software product for an intelligent personal computer workstation.

A further object of the invention is to provide improved software back-up means capable of continual, on-line, automatic back-up of a primary logical drive to a secondary logical drive, especially, but without restriction, under DOS on a network.

Further objects lie in providing improved computer systems employing said data-loss prevention software product.

Accordingly, there is provided a data-loss prevention software product for an intelligent personal-computer workstation which workstation is connected to a plurality of logical drives for data storage each of which logical drives is a random-access storage device or a sub-division thereof, and which workstation has data-entry means for a user to input data to the workstation and has random-access-main-memory areas (RAM) capable of supporting system software and an application to receive data-entry instructions from said data-entry means and generate data-related drive requests, which application can include a system software user-interface, wherein the software product comprises executable code which includes:

- a) command means to load the executable code into workstation RAM;
- b) user interface means enabling a user to specify one of said drives as a primary logical drive to be replicated;
- c) system request filter means to examine system requests generated by the application and intercept a primary logical drive request before it is processed by the drive sub-system;
- d) drive-request processor means to replicate and issue the first drive request to a user-specified secondary

CLAIMS

1. A data-loss prevention software product for an intelligent personal-computer workstation which workstation is connected to a plurality of logical drives for data storage each of which logical drives is a random-access storage device or a sub-division thereof, and which workstation has data-entry means for a user to input data to the workstation and has random-access-main-memory areas (RAM) capable of supporting system software and an application to receive data-entry instructions from said data-entry means and generate data-related drive requests, which application can include a system software user-interface , wherein the software product comprises executable code which includes:

- a) command means to load the executable code into workstation RAM;
- b) user interface means enabling a user to specify one of said drives as a primary logical drive to be replicated;
- c) system request filter means to examine system requests generated by the application and intercept a primary logical drive request before it is processed by the drive sub-system;
- d) drive-request processor means to replicate and issue the first drive request to a user-specified secondary of said logical drives before issuing a succeeding

drive-request to the primary drive; and

e) means to process a succeeding drive request in a similar manner to said first drive request after issuing said first drive request to said secondary drive;

thereby to be capable of automatically and continually maintaining a functionally identical mirrored data image on said secondary drive of the data activity issued to the primary drive by said primary drive requests, without user intervention.

2. A software product according to claim 1 wherein all primary drive requests are processed as recited therein, thereby to be capable of maintaining a complete data image of said primary drive on said secondary drive.

3. A software product according to claim 1 which also includes:

drive-return analyzer means to examine returns from said logical drives; and

error-handling means which includes user-alerting means;

whereby a good drive return permits the issuance of the next succeeding drive request and a return signifying an unrecoverable disk error activates said user-alerting means.

4. A software product according to claim 3 wherein said system request filter means intercepts both primary drive reads

and primary drive writes and drive read returns are examined by the drive-return analyzer.

5. --- A software product according to claim 1 for a DOS computer wherein said software product and workstation are respectively capable of running under and running Microsoft Corporation's MS-DOS v. 3.1 or higher, or IBM Corporation's PC-DOS v. 3.1 or higher, or functional equivalents of either.

6. A software product according to claim 5 wherein said system request filter means uses a DOS interrupt to intercept primary drive requests.

7. A software product according to claim 1 comprising automatic means to continue processing data in the event of a failure of the primary drive which automatic means comprises: means to generate a user alert; and means to switch processing to said secondary drive using the functionally identical data image replicated thereon.

8. A software product according to claim 7 wherein said automatic means to continue processing comprises a critical error handler to suspend processing and take over system control.

9. A software product according to claim 8 wherein the critical error handler can act to instruct the drive request

processor to direct drive requests solely to a surviving drive or drives.

10. -- A software product according to claim 9 including means to permit a user to elect to discontinue processing in the event of drive failure wherein the critical error handler includes routines to close open files and exit gracefully.

11. A software product according to claim 10 characterized by being capable of occupying less than 30 KB of RAM when loaded in normal main memory and of reducing workstation application-processing performance by no more than 10%.

12. A software product according to claim 1 adapted to provide data replication to multiple secondary drives.

13. A software product according to claim 1 supplied on a transportable drive medium and packaged with a hard copy of detailed instructions for the installation and use of said software product.

14. An intelligent personal computer workstation which comprises:

- a) data-entry means for a user to input data to the workstation;
- b) random-access-main-memory areas (RAM) capable of

supporting system software and an application;

c) said data-entry means being usable to input data-changing activity to said application, wherein the workstation is connected to a plurality of logical drives for data storage each of which logical drives is a random-access storage device or a sub-division thereof, in combination with a data-loss prevention software product comprising executable code which includes:

d) command means to load the executable code into workstation RAM;

e) user interface means enabling a user to specify one of said drives as a primary logical drive to be replicated;

f) system request filter means to examine system requests generated by said application and intercept a first primary logical drive request;

g) drive-request processor means to replicate and issue the first drive request to a user-specified secondary of said logical drives before issuing a succeeding drive-request to the primary drive; and

h) means to process a succeeding drive request in a similar manner to said first drive request after issuing said first drive request to said secondary drive;

thereby to be capable of automatically and continually

maintaining a functionally identical mirrored data image on said secondary drive of the data activity issued to the primary drive by said primary drive requests, without user intervention.

15. A workstation according to claim 14 which is a DOS computer wherein said software product and workstation are respectively capable of running under and running Microsoft Corporation's MS-DOS v. 3.1 or higher, or IBM Corporation's PC-DOS v. 3.1 or higher, or functional equivalents of either.
16. A workstation according to claim 14 wherein the software product includes automatic means to continue processing data in the event of a failure of the primary drive which automatic means comprises: means to generate a user alert; and means to switch processing to said secondary drive using the functionally identical data image replicated thereon.
17. A workstation according to claim 16 wherein the critical error handler can act to instruct the drive request processor to direct drive requests solely to a surviving drive or drives.
18. A computer network comprising an interconnected file server and a workstation-and-software product as set forth in claim 14 wherein said primary logical drive is located on the file server.

19. A network according to claim 18 comprising a plurality of such workstations and associated software product, wherein each of said workstations can be installed to use the same logical drive on the file server as its primary logical drive.

20. A network according to claim 19 further comprising at least one backup file server connected to the workstations wherein the workstations can each use the same logical drive on the backup file server as their secondary drive.

21. A personal computer network comprising a primary file server having a primary logical drive for data storage, a backup file server having a secondary logical drive for data storage each of which logical drives is a random-access storage device or a sub-division thereof, and comprising a plurality of intelligent personal computer work stations connected to each said file server wherein each of said work stations includes:

a) data-entry means for a user to input data to said workstation; and

b) random-access-main-memory areas (RAM) capable of supporting system software and an application, said data-entry means being usable to input data-changing activity to said application;

in combination with a data-loss prevention software product at each workstation which product comprises executable code which code includes:

- c) command means to load the executable code into workstation RAM;
- d) system request filter means to examine system requests generated by said application and intercept a first primary logical drive request;
- e) drive-request processor means to replicate and issue the first drive request to a user-specified secondary of said logical drives before issuing a succeeding drive-request to the primary drive; and
- f) means to process a succeeding drive request in a similar manner to said first drive request after issuing said first drive request to said secondary drive;

thereby to be capable of automatically and continually maintaining a functionally identical mirrored data image on said secondary drive of the data activity issued to the primary drive by said primary drive requests, without user intervention.

22. A computer network according to claim 21 wherein the software product includes automatic means to continue processing data in the event of a failure of the primary drive which automatic means comprises: means to generate a user alert; and means to switch processing to said secondary drive using the functionally identical data image replicated thereon.

23. A method of preventing data loss on an intelligent

personal computer workstation which method includes the steps of:

- a) sequentially inputting first then second data then subsequent data segments;
- b) generating a first drive request for storage of said first data segment on a primary logical drive being a random-access storage device or a sub-division thereof;
- c) intercepting said first drive request;
- d) replicating and sending said intercepted first drive request to said primary logical drive;
- e) relabeling and sending the replicated first drive request to a secondary logical drive for storage thereon, said secondary logical drive also being a random-access storage device or a sub-division thereof;
- f) subsequently to said sending of said replicated first drive request to said secondary logical drive, generating a second drive request for storage of said second data segment on said primary logical drive;
- g) processing said second drive request in the same manner as the first drive request; and
- h) repeating the drive-request processing for subsequent data segments;

thereby to produce a functionally identical data image on said secondary logical drive of the data on said primary logical drive.

24. A method according to claim 23 for preventing data loss

on a DOS computer wherein said data-loss-prevention steps are carried out in RAM under DOS, which DOS is Microsoft Corporation's MS-DOS v. 3.1 or higher, or IBM Corporation's PC-DOS v. 3.1 or higher, or functional equivalents of either.

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